Update on LeptoSusy sample studies

Simona

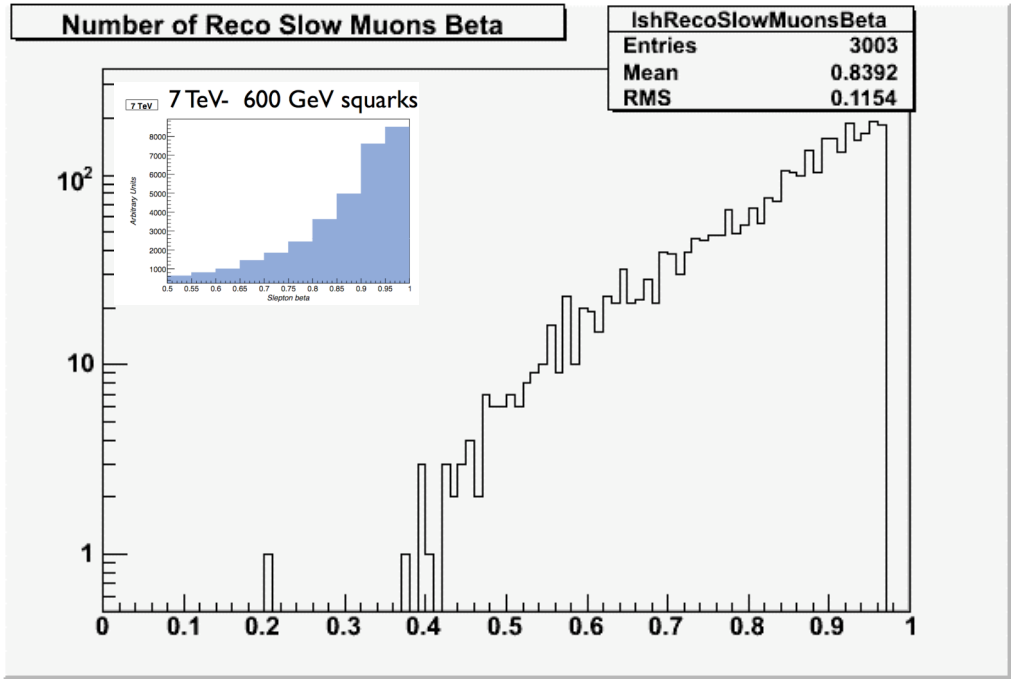
Outline

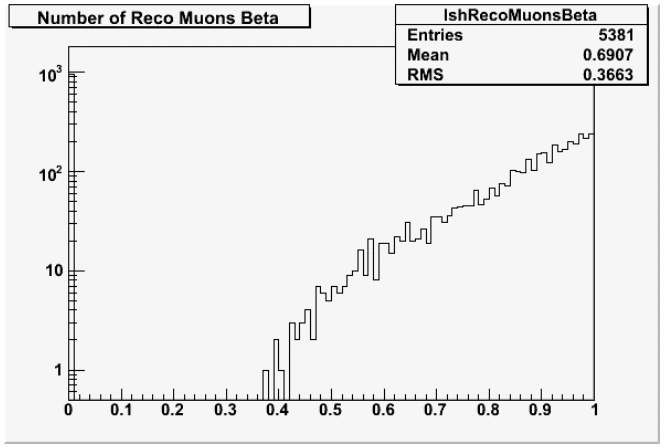
- Ntuple status
  - Beta of slow muons
  - More taggers info
  - Tow ntuples for different Muon Collections
- Slow Muons beta distribution
  - Trigger efficiency
- Analysis cuts efficiency
  - Revised number of expected events
- Btgging
  - Preliminary Btag efficiency for Jet Probability
- Note
- To Do List

Ntuple status

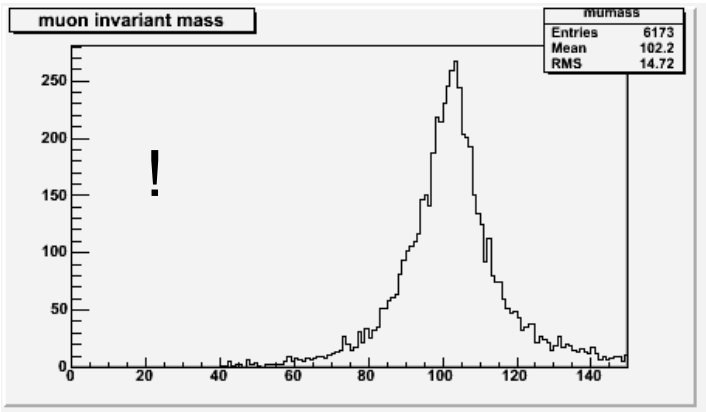
- Fixed an error in filling beta for MuGirlLowBetaCollection muons
  - Slepton mass reconstruction now ok - Veronica
- Added two more tagger weights:
  - Jet Probability
  - Tracking counting (empty?)
- Made two ntuples for MuID and StacoMuon
- List of variables at:
  - http://ncdf70.fnal.gov:8001/atlas/JustSignalFull.h
- Ntuple at:http://ncdf70.fnal.gov:8001/atlas/
  - EvtNtuple.aan.justSignal.FullSimJorge.Allevt.AllJets.Trigger.MuIDMuons.root
  - EvtNtuple.aan.justSignal.FullSimJorge.Allevt.AllJets.Trigger.StacoMuons.root

Beta of Muons and Slow Muons

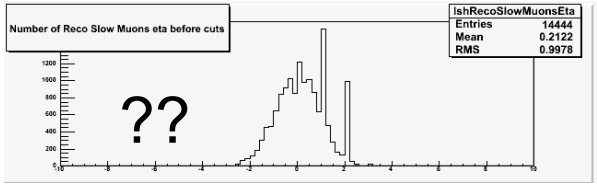




Beta is also calculated for MuID muons: if they are mutually exclusive to LowBetaMuGirl, maybe we should use them?
(increase acceptance…)
Is this beta correct??

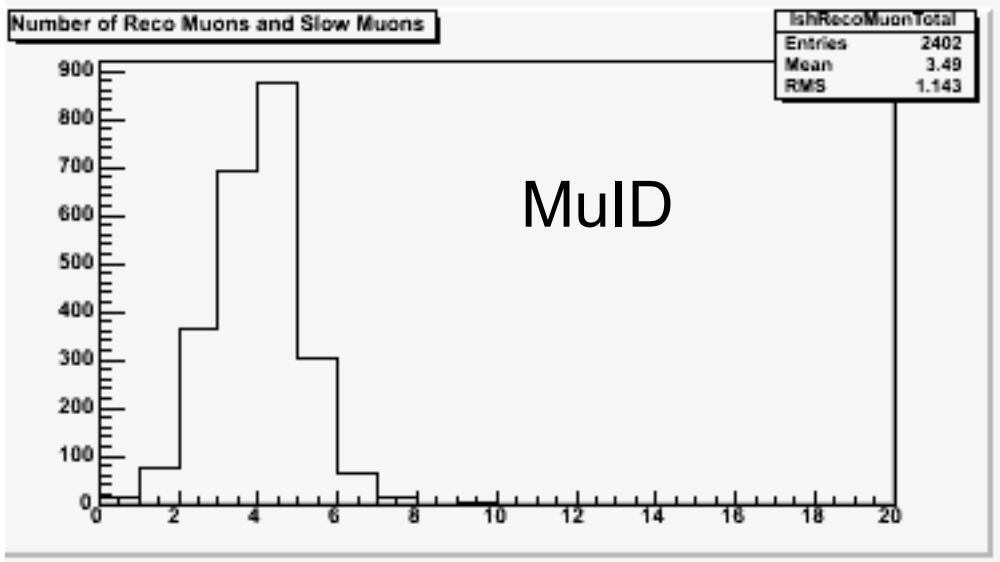


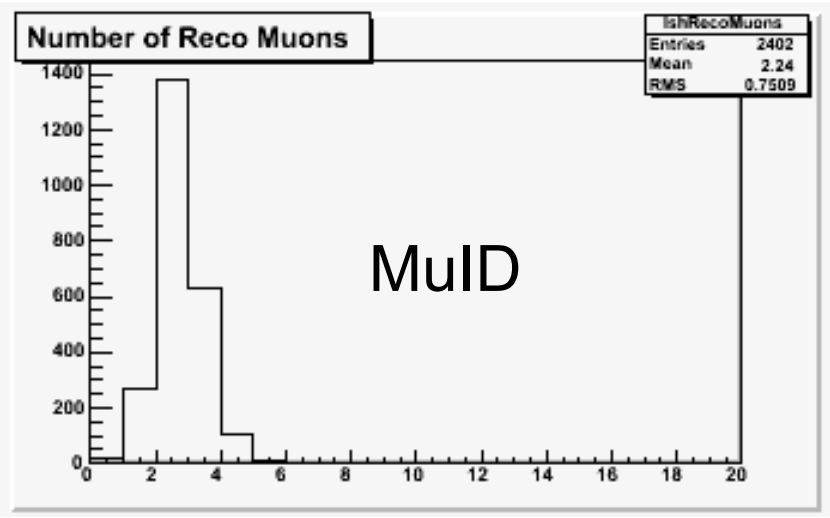
Reco Slow muon mass (Veronica)



Strange eta distribution for slow muons before any cut…

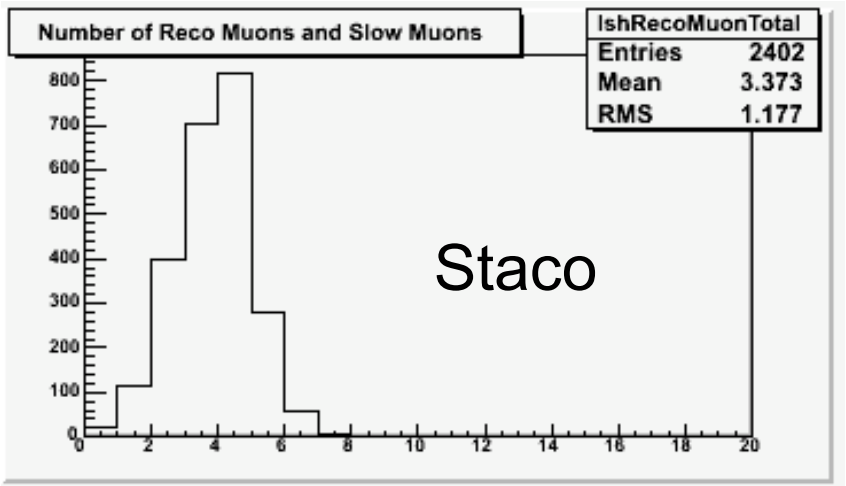
Total Muon multiplicity:muID vs Staco

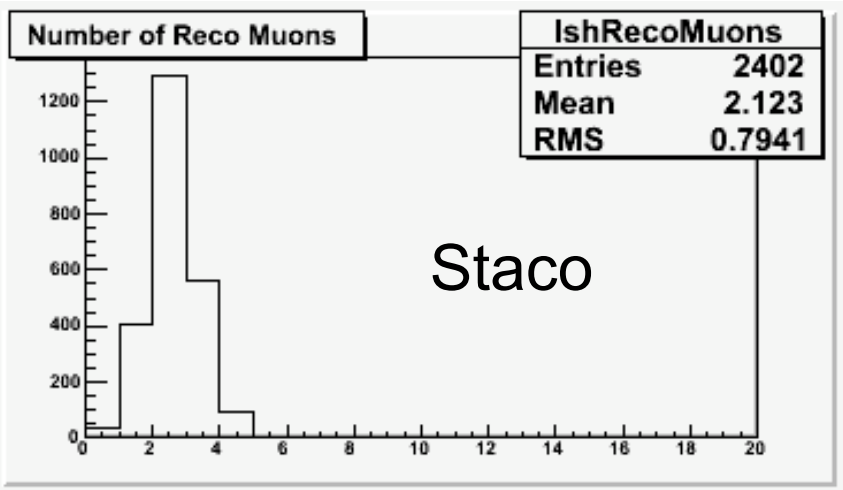




ET > 25 $|\eta| < 2.5$

Too high…Need cleanup?





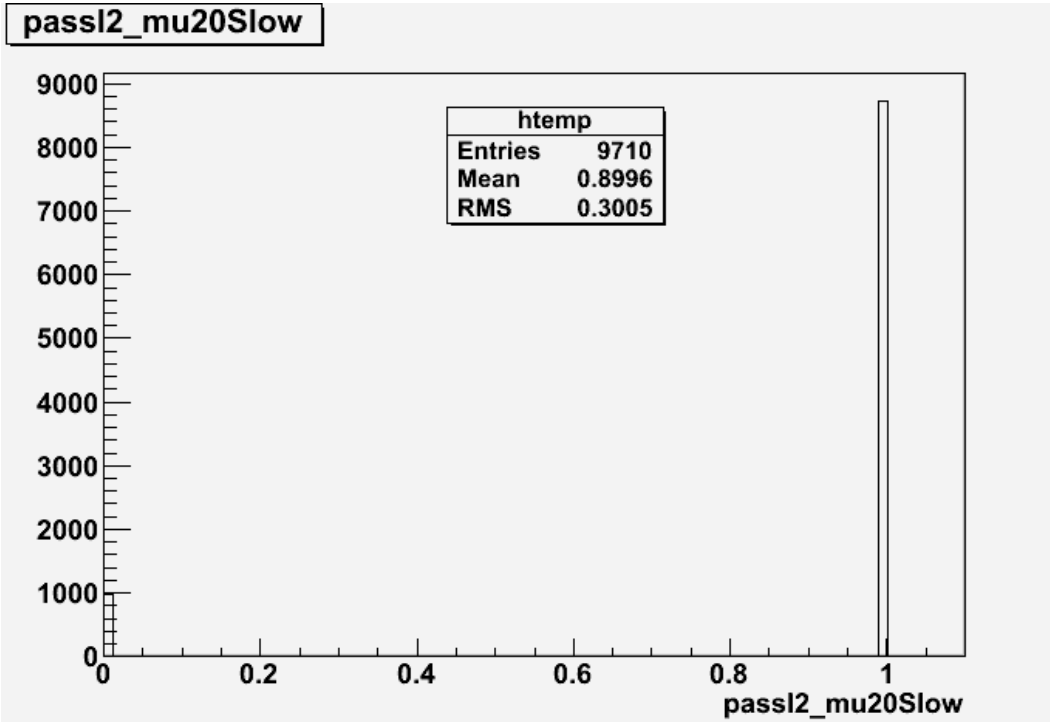
Offline "Trigger"

- Let's assume that we use a trigger of a single slow muon with PT > 25 GeV and $\beta > 0.5$
- I selected such events in the signal-only and background samples:
  - Signal only:2067/2402 = 86%
  - Background:6185/7308 = 84%

Corrected from last time: more in sync with online trigger eff (89%)

Preliminary Look at Trigger Info

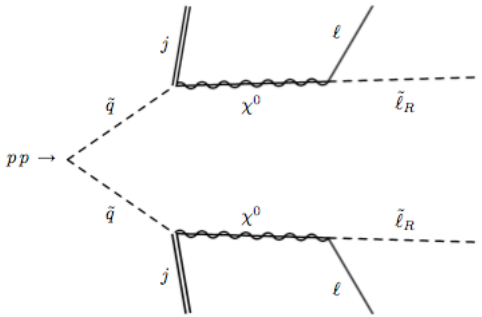
- Looked at events passing L2_mu20_slow:
  - STAT Trigger Statistics on 9710 processed events
  - STAT Passed events for chain L2_mu20_slow 8735 (89.9588%)



New variable in the nutple: passl2_mu20Slow

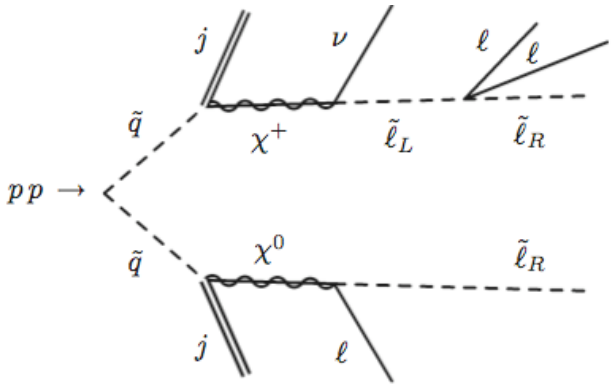
For efficiency curves need TrigMuGirl collection?

Signal and Background



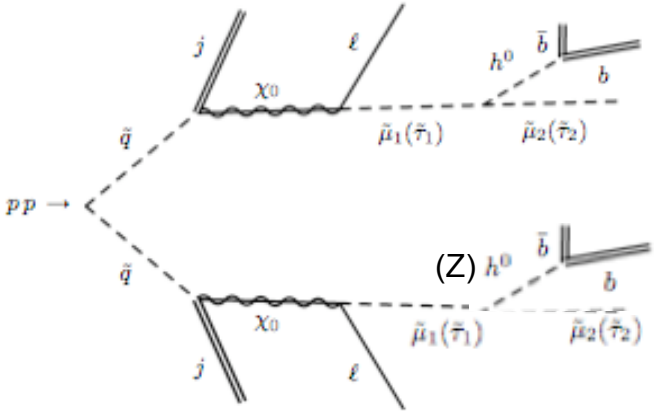
Final state topologies w/o Higgs

-4 leptons (2 slow)
-5 leptons (2 slow)
-6 leptons (2 slow)
-At least 2 jets



Final state topology with 1(2) Higgs

-At least 4 leptons (2 slow)
-At least 4 jets (sometime 6)
-At least 2 btagged jets (sometime 4)



Strategy

trigger on slow leptons, ask for high jet multiplicity, require b-tag

A first run at event selection

- Current Selection:
  - 1 slow muon PT > 25, eta < 2.5
  - At least 5 jets with ET > 25 GeV eta < 2.5
    - Several jet multiplicity cut to optimize S/B
    - Not much difference: (6 jets also presented)
  - Following Veronica lead in disregarding the first 2 jets….
  - Jet 3 and 4 with btag weight cut > -3,-2,-1,0
    - Several tag weights used to calculated tagging efficiency and Rejection factor
  - Dijet invariant mass cut ? ($95 < m_{j3j4} < 200$) ? Not for now
- Calculated signal retention and background elimination (S/B) - corrected from last time

Results:

Weight cut > -3

========ANALYSIS CUTS ==========

Number of events with one slepton trigger 2067
Number of events with one slepton trigger and 5 jets 2048
Number of events with one slepton trigger and 5 jets with cuts 1921
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -3 1026
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -3 and dijet mass between 95 and 200 524
========Background ==========
Number of events w/o Higgs 7308
Number of events with one slepton trigger 6185
Number of events with one slepton trigger and 5 jets 5936
Number of events with one slepton trigger and 5 jets with cuts 4889
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -3 2762

Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -3 and dijet mass between 95 and 200 1298

S/B=1026/2762

1017/2612

Weight cut > -2

Njet ≥ 6

========ANALYSIS CUTS ==========
Number of events with one slepton trigger 2067
Number of events with one slepton trigger and 5 jets 2048
Number of events with one slepton trigger and 5 jets with cuts 1921
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -2 696
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -2 and dijet mass between 95 and 200 351
========Background ==========
Number of events w/o Higgs 7308
Number of events with one slepton trigger 6185
Number of events with one slepton trigger and 5 jets 5936
Number of events with one slepton trigger and 5 jets with cuts 4889
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -2 1849
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -2 and dijet mass between 95 and 200 851

S/B = 696/1849

629/1672

Results:

Weight cut > -1

========ANALYSIS CUTS ==========
Number of events with one slepton trigger 2067
Number of events with one slepton trigger and 5 jets 2048
Number of events with one slepton trigger and 5 jets with cuts 1921
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -1 285
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -1 and dijet mass between 95 and 200 151
========Background ==========
Number of events w/o Higgs 7308
Number of events with one slepton trigger 6185
Number of events with one slepton trigger and 5 jets 5936
Number of events with one slepton trigger and 5 jets with cuts 4889
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -1 211

Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than -1 and dijet mass between 95 and 200 102

S/B = 285/211

283/200

Weight cut > 0

========ANALYSIS CUTS ==========
Number of events with one slepton trigger 2067
Number of events with one slepton trigger and 5 jets 2048
Number of events with one slepton trigger and 5 jets with cuts 1921
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than 0 201
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than 0 and dijet mass between 95 and 200 107
========Background ==========
Number of events w/o Higgs 7308
Number of events with one slepton trigger 6185
Number of events with one slepton trigger and 5 jets 5936
Number of events with one slepton trigger and 5 jets with cuts 4889
Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than 0 97

Number of events with one slepton trigger and 5 jets with cuts and btag weight greater than 0 and dijet mass between 95 and 200 48

S/B = 201/97

199/94

How many events in 1fb^{-1}?

- Assuming a cross section of 320 fb for Higgs-only events and 1080 for bkgr:
  - Trigger: 86% (84.6) 275 913
  - ≥6 jets : 84% (75.3) 268 813
  - 6 jets with cuts : 79% (63.7) 252 687
  - 2 bjets: 12% (2.7)(cut Weight > -1) 38 29
  - 2 bjets: 8% (1.3)(cut Weight > 0) 25 14

Btagging studies

- Weight cut for IP3D+SV1
  - Efficiency and mistag
  - Eta and PT plots
- Preliminary look at Jet Probability

B-tagging performance estimators

- B-jet efficiency ε_b as function of weight cut:
  - Denominator:
    - jets defined as b using MC truth
      - with fixed p_T and η cuts (p_T> 25 GeV/c, $|\eta|$<2.5)
  - Numerator:
    - ditto + cut on a tagging weight
- Light-jet rejection $R_u = 1 / \varepsilon_u$
  - R=100 means 1% mistag rate
  - light jets: u, d, s, g
- B-jet efficiency as a function of P_T and η
  - Denominator:
    - jets defined as b using MC truth
      - with fixed cut on weight (SV1 > 3, LHSig > 0.9, …)
  - Numerator:
    - ditto + cut on p_T and η

Weight Cut

- From the b-tagging official page:
  (https://twiki.cern.ch/twiki/bin/view/AtlasProtected/BTaggingFAQ#Choosing_a_cut_value)
  - By cutting on the b-tagging weight, you choose a working point defining a certain b-tagging efficiency `eps_b` and a level of rejection of light jets `R_u`. This choice is very analysis-dependent (mostly via jet pT/eta spectra), therefore the b-tagging group does not recommend a cut. In addition, the relation between the cut value and `(eps_b, R_u)` is not univoqual: it depends on the sample, the release and the b-tagging calibrations.

- I then proceed to do efficiency and rejection studies

Btagging efficiency and Rejection factors

≥ 6 jets

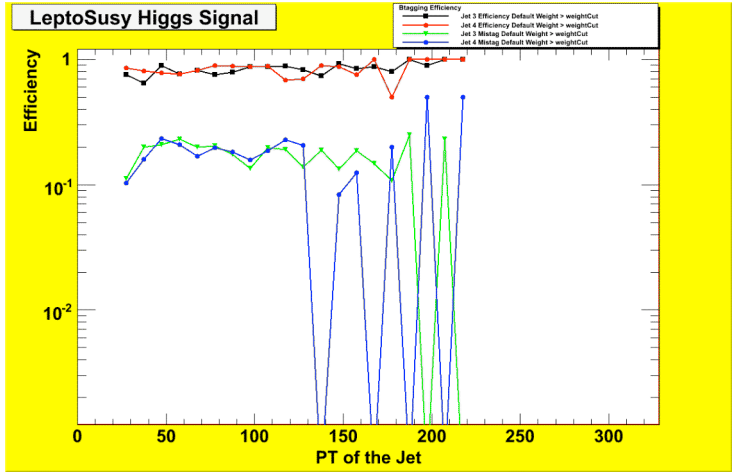
Weight Cut	W > -3	W > -2	W > -1	W > 0
ε(b)	81%	76%	71%	63%
Mistag rate	40-55%	22-36%	3%	1.4%

≥ 5 jets

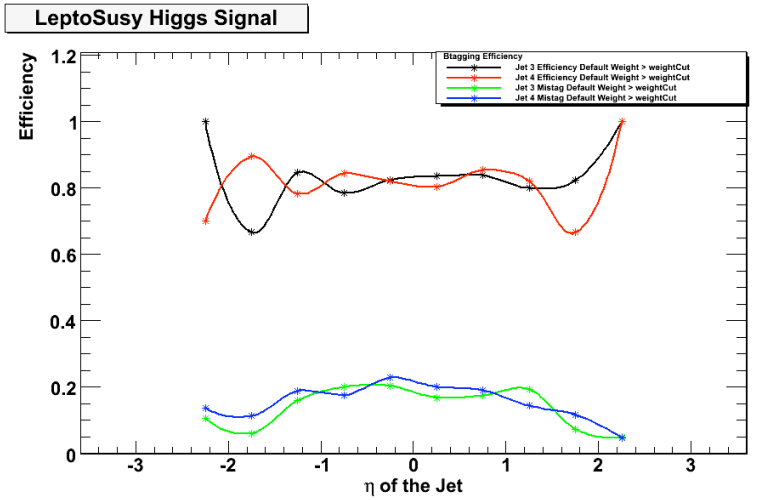
Weight Cut	W > -3	W > -2	W > -1	W > 0
ε(b)	81%	76%	71%	63%
Mistag rate	40-55%	22-36%	3%	1.2%

```
if (jetET[2] > 25 && jetET[3] > 25 && fabs(jetEta[2]) < 2.5 && fabs(jetEta[3]) < 2.5) {

     if ( fabs(jetFlavor[2]) == 5 && fabs(jetFlavor[3]) == 5) {
               bTagDenominator++;
               if (jetWeight[2] > weightCut && jetWeight[3] > weightCut) bTagNumerator++;
     }// if ( fabs(jetFlavor[2]) == 5 && fabs(jetFlavor[3]) == 5)

     if ( fabs(jetFlavor[2]) != 5 && fabs(jetFlavor[3]) != 5) {
                RTagDenominator++;
                if (jetWeight[2] > weightCut && jetWeight[3] > weightCut) RTagNumerator++;
     }// if ( fabs(jetFlavor[2]) != 5 && fabs(jetFlavor[3]) != 5)

} // if (jetET[2] > 25 && jetET[3] > 25 && fabs(jetEta[2]) < 2.5 && fabs(jetEta[3]) < 2.5)
```

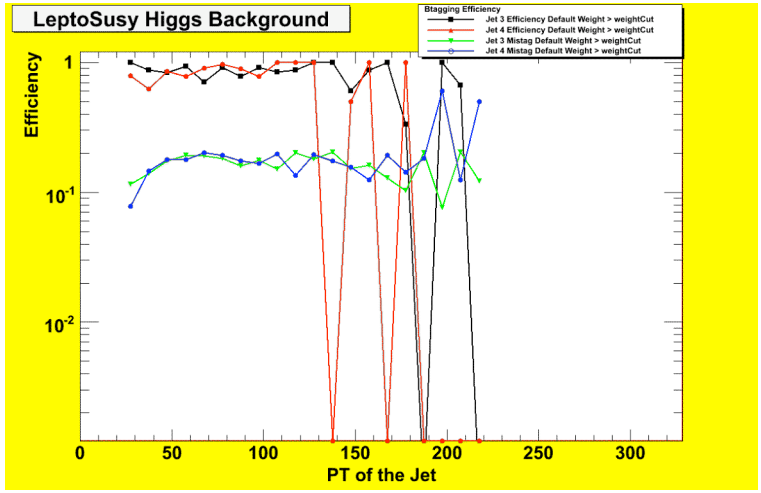
Efficiency and Mistag



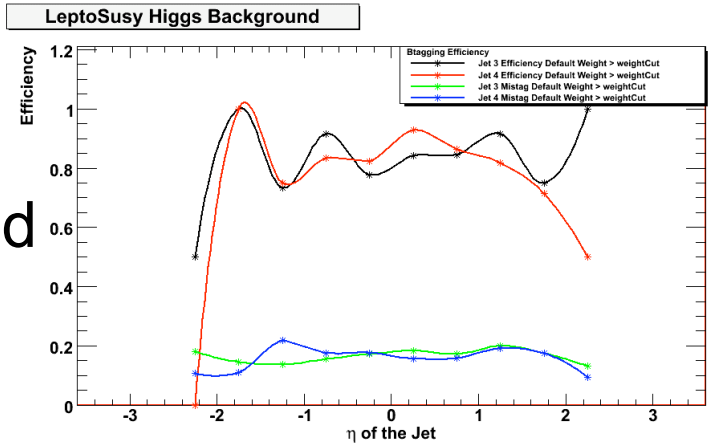
Signal



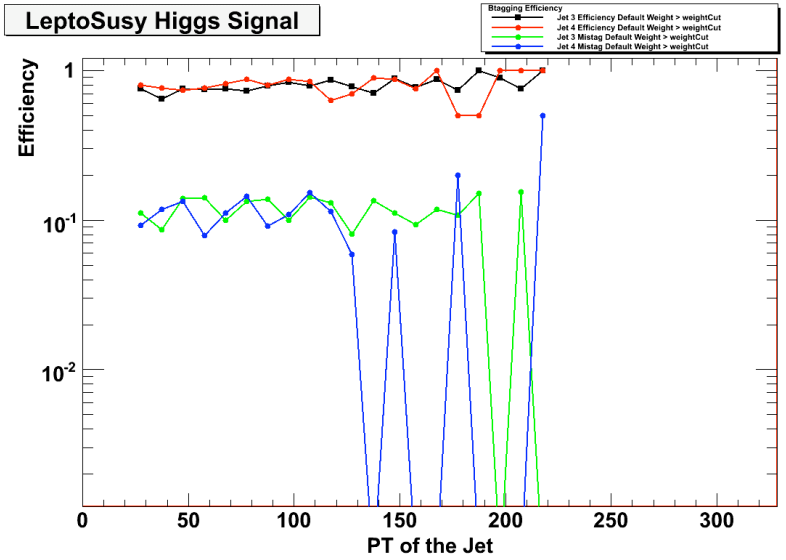
Weight > -1



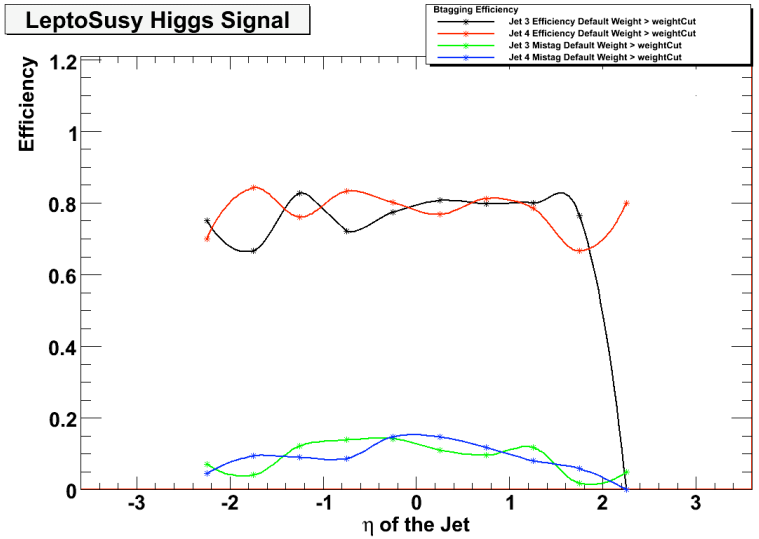
Background



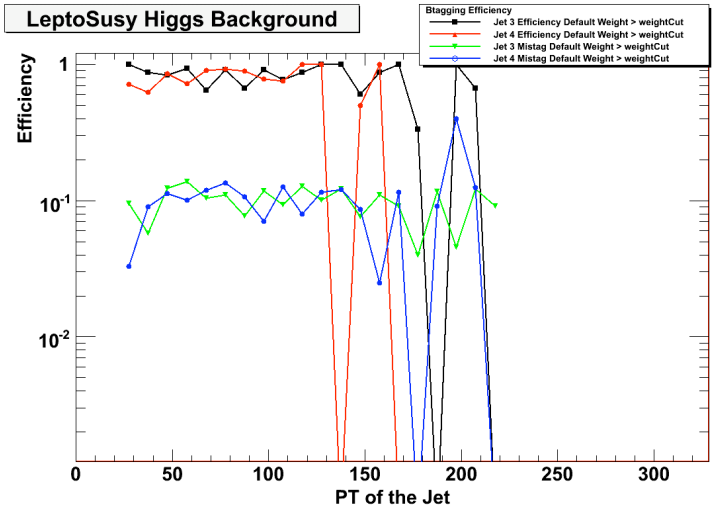
Efficiency and Mistags



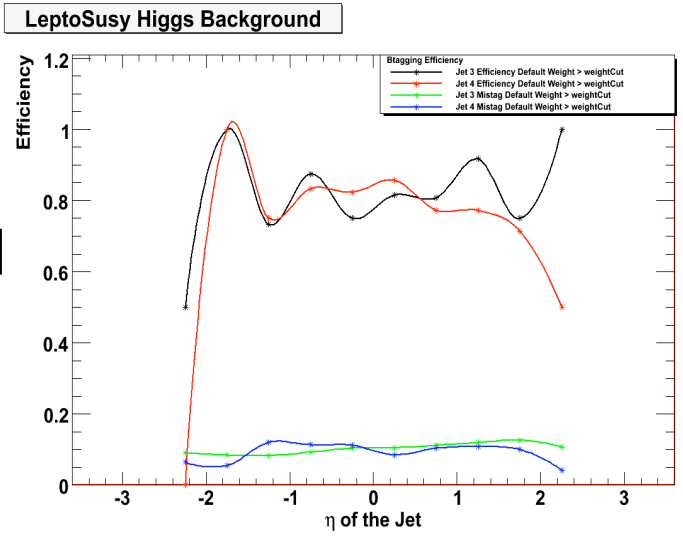
Signal



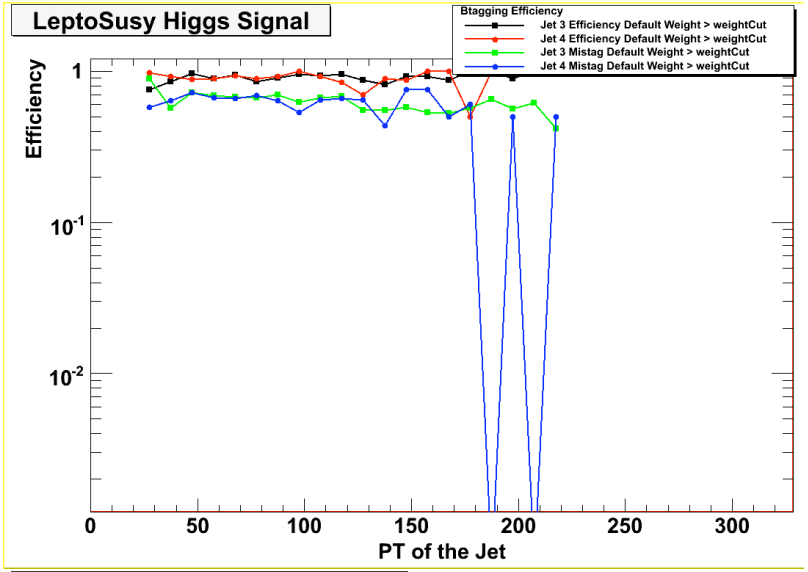
Weight > 0



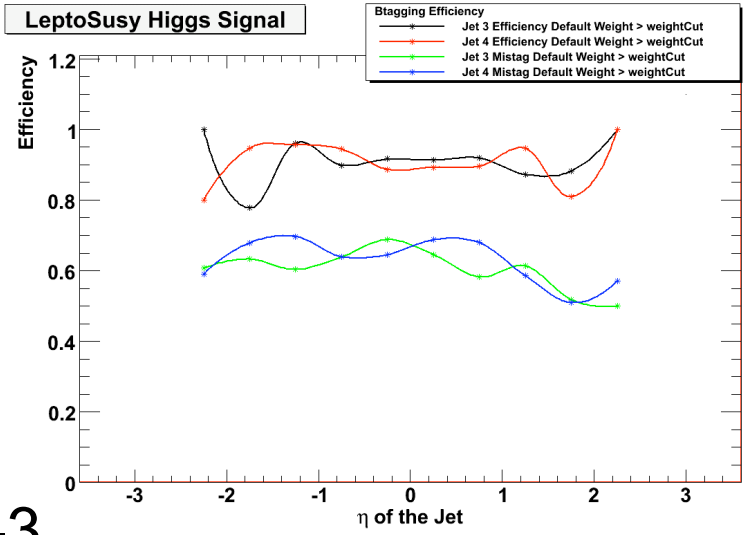
Background



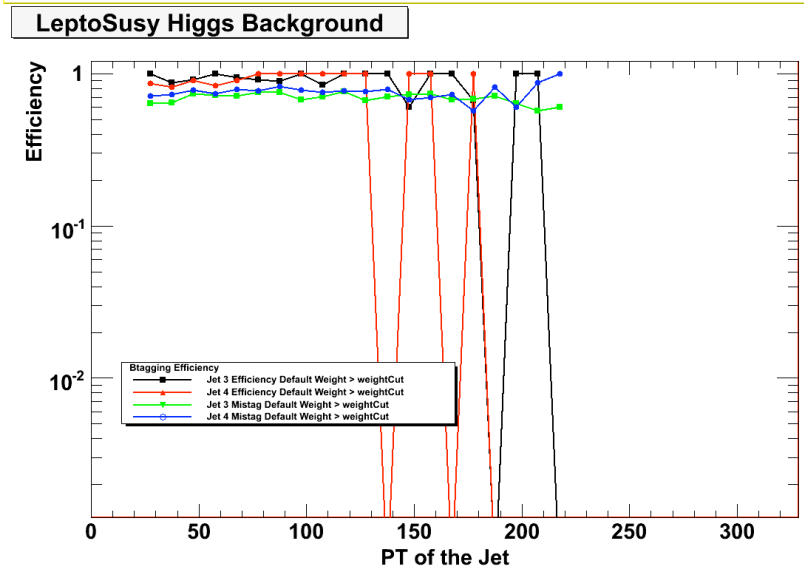
Efficiency and Mistags



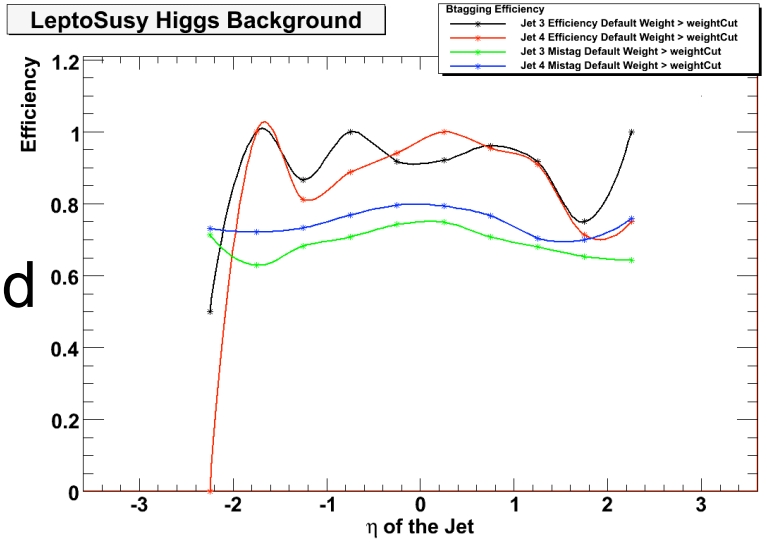
Signal



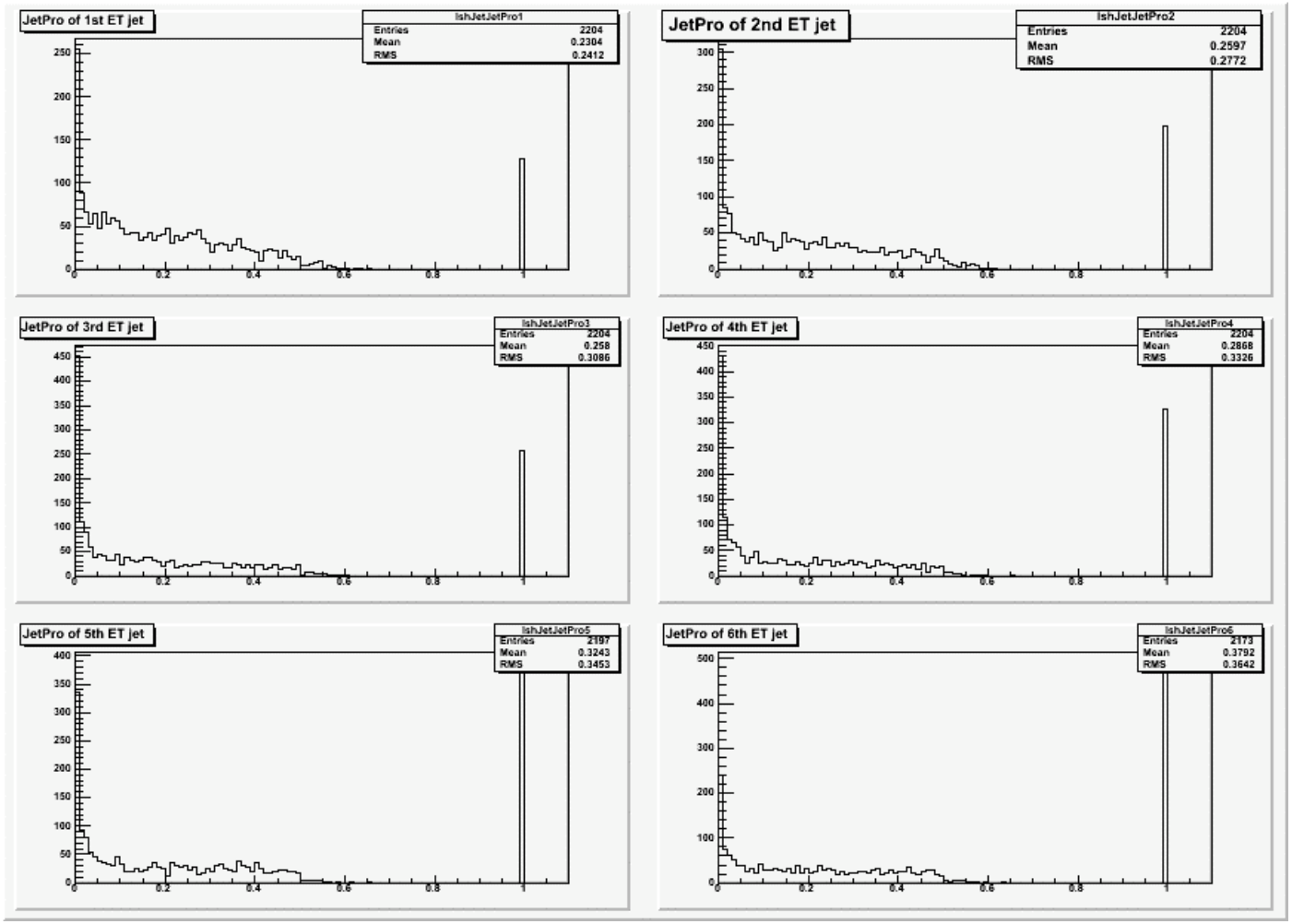
Weight > -3



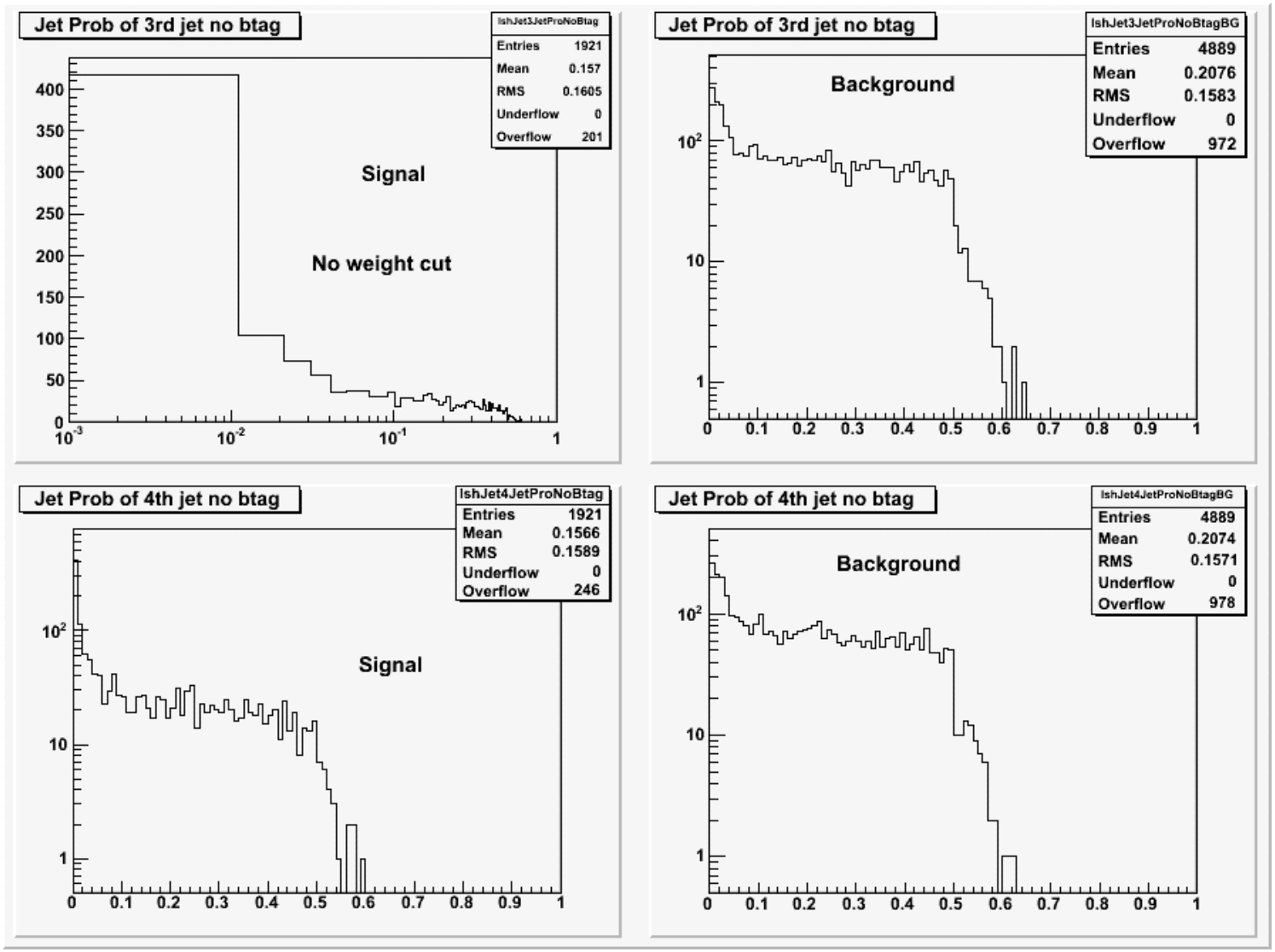
Background



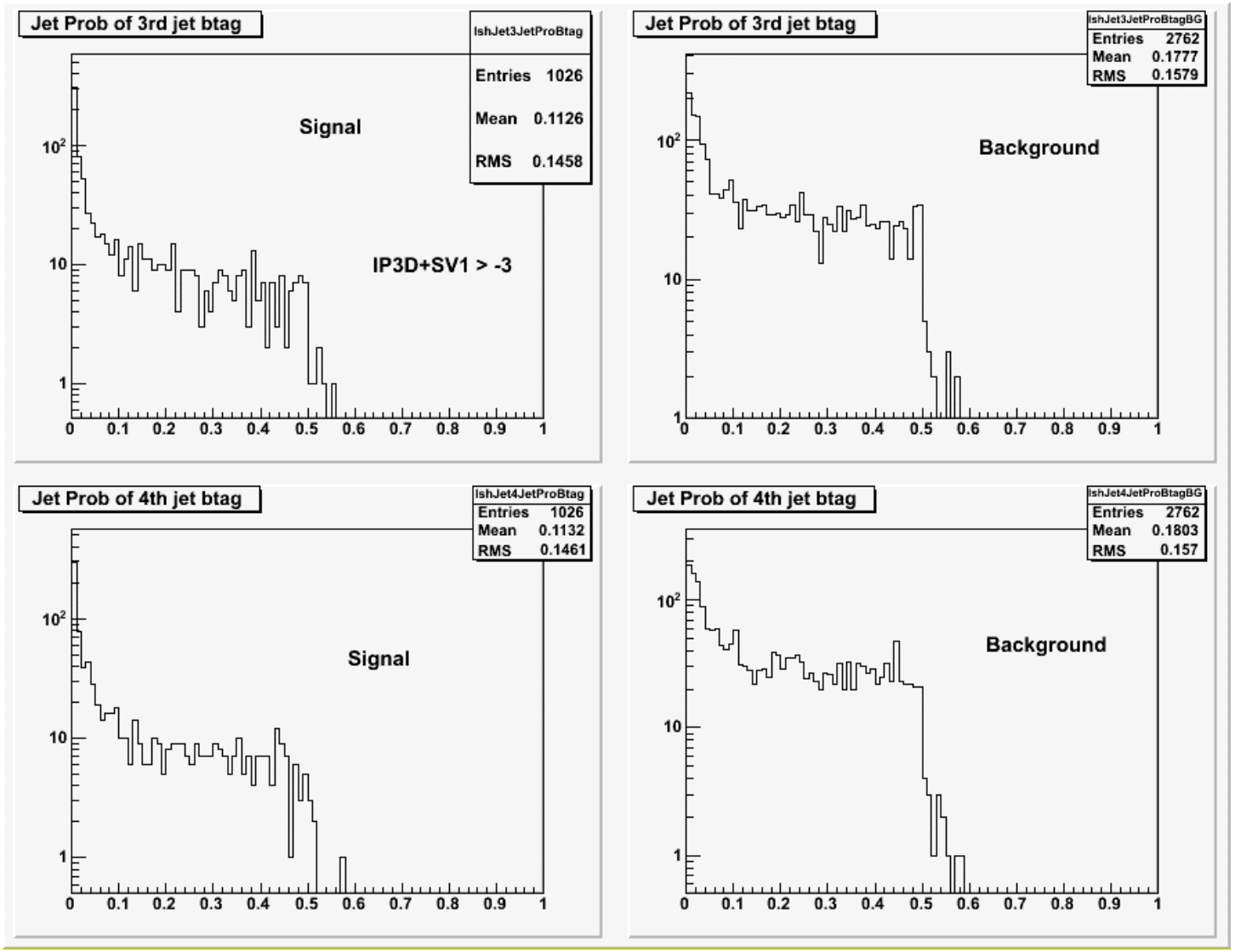
Alterative taggers: Jet Probability



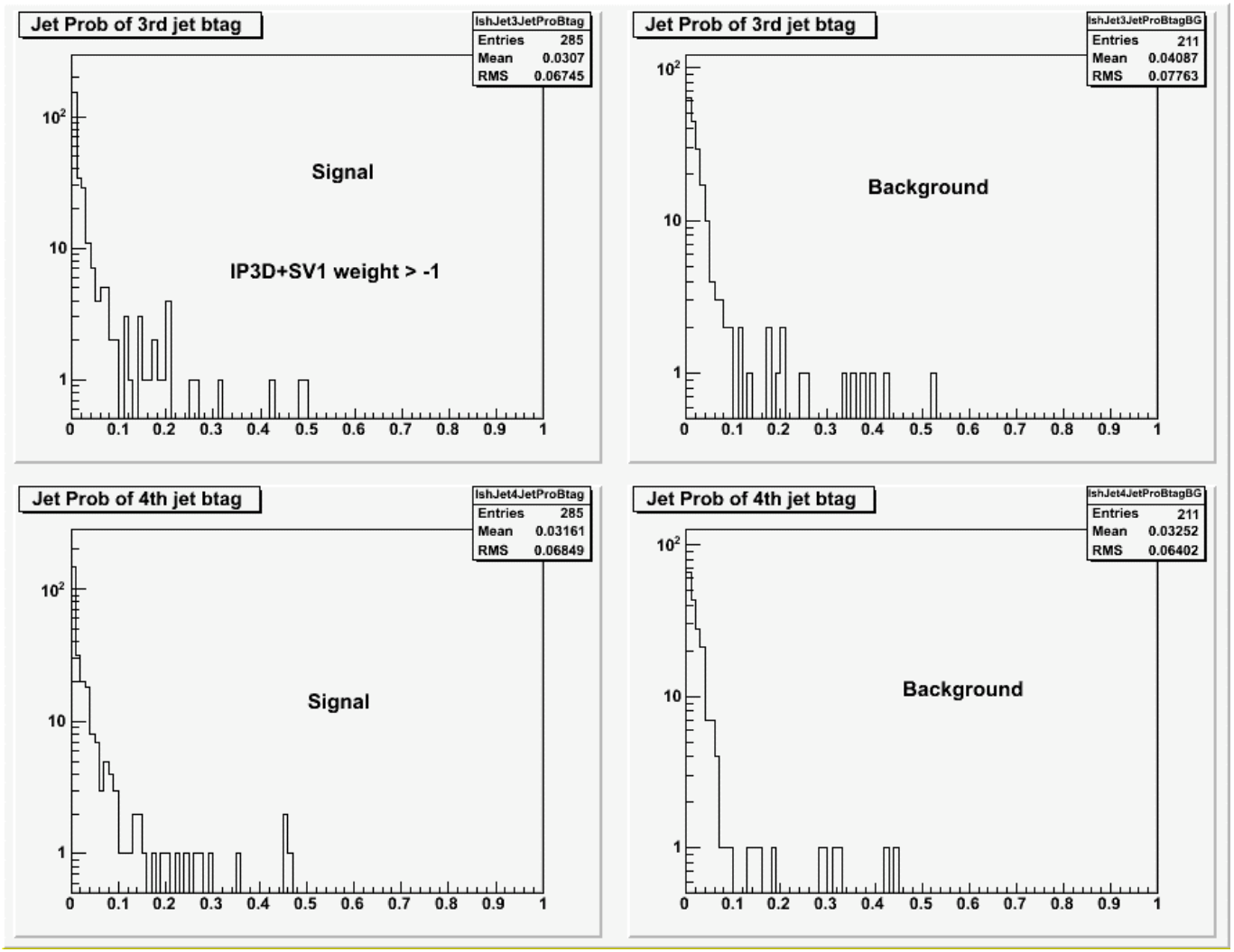
Alternative taggers: Jet Probability



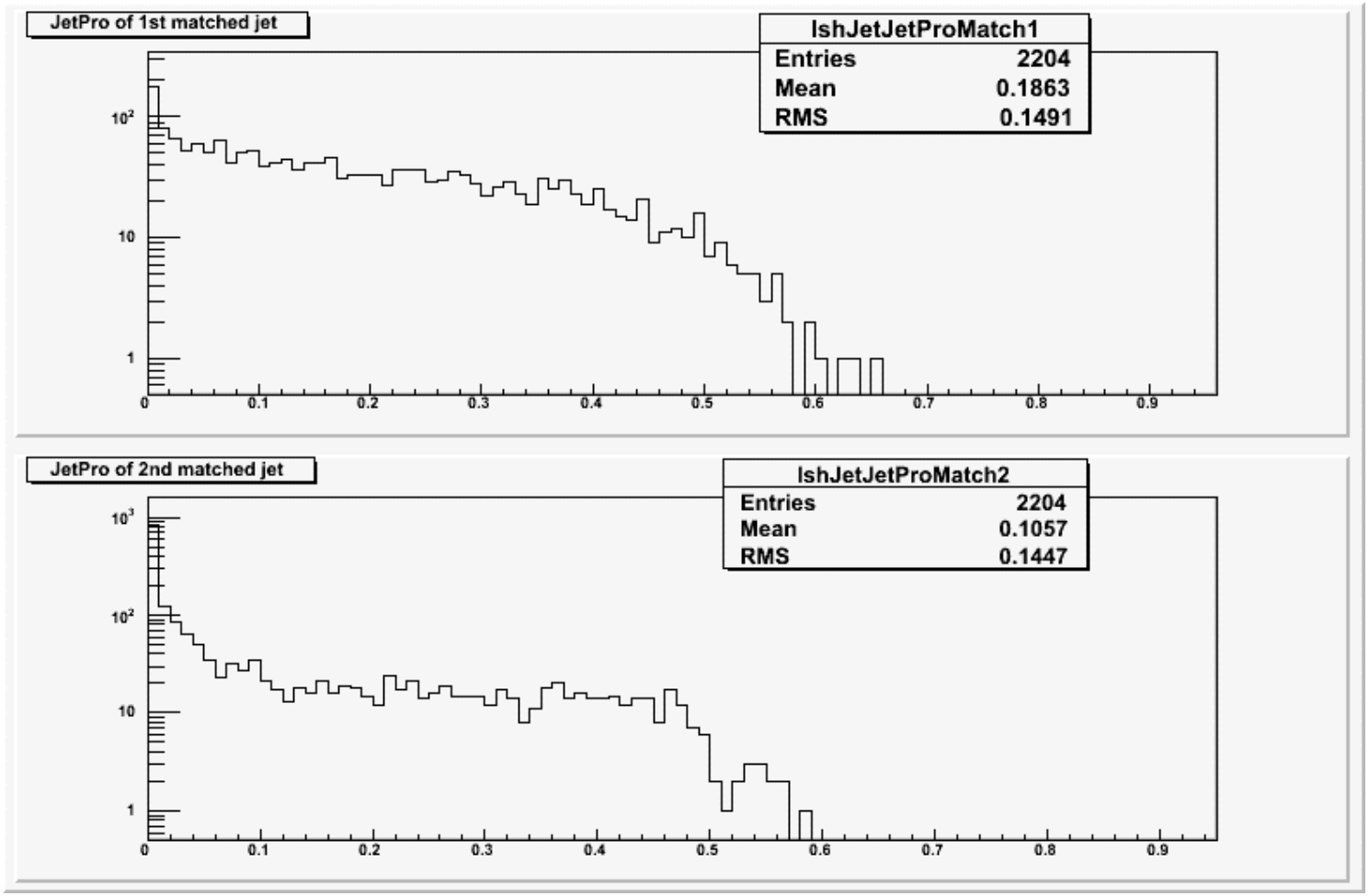
Jet Probability



Jet Probability



Jet Probability



JetProb efficiency

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Number of events with one slepton trigger and 5 jets with cuts and btag Jet Prob less than 0.1 383
========Background ==========
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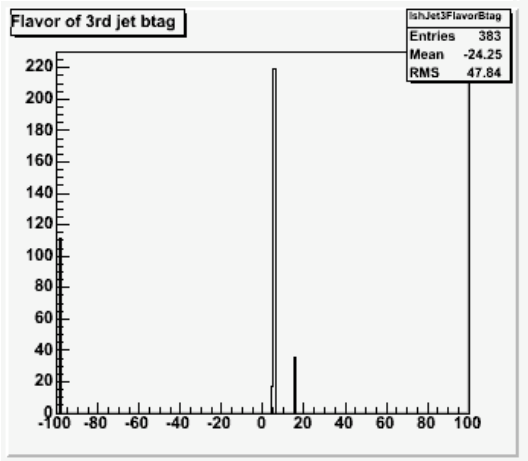
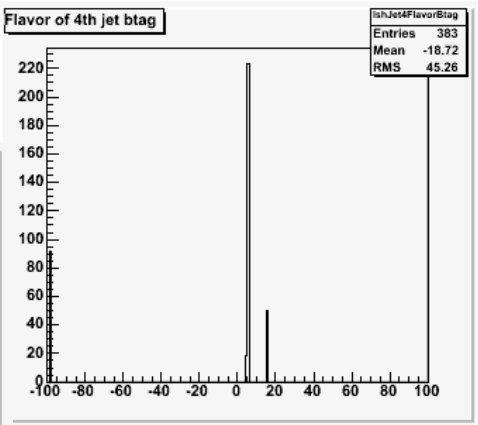
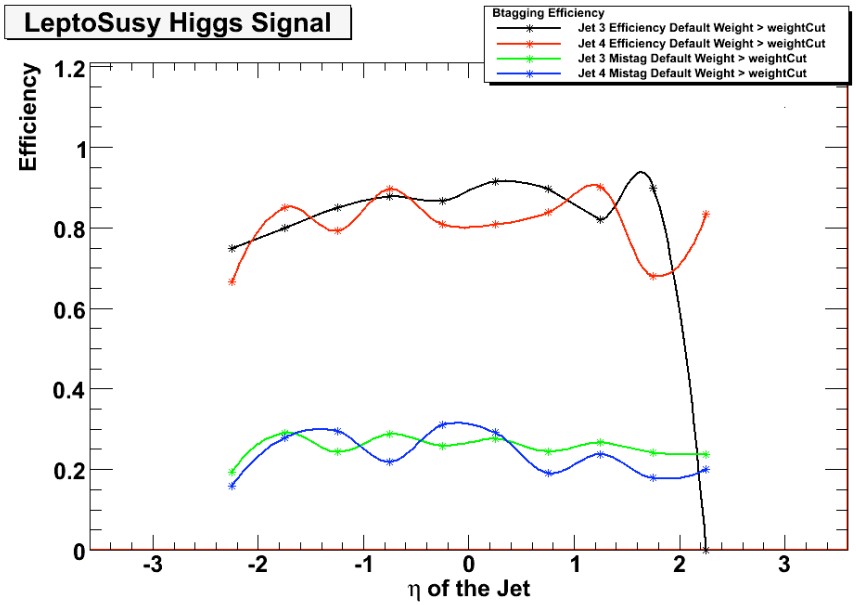
Number of events with one slepton trigger 6185
Number of events with one slepton trigger and 5 jets 5936
Number of events with one slepton trigger and 5 jets with cuts 4889
Number of events with one slepton trigger and 5 jets with cuts and btag Jet Prob less than 0.1 395

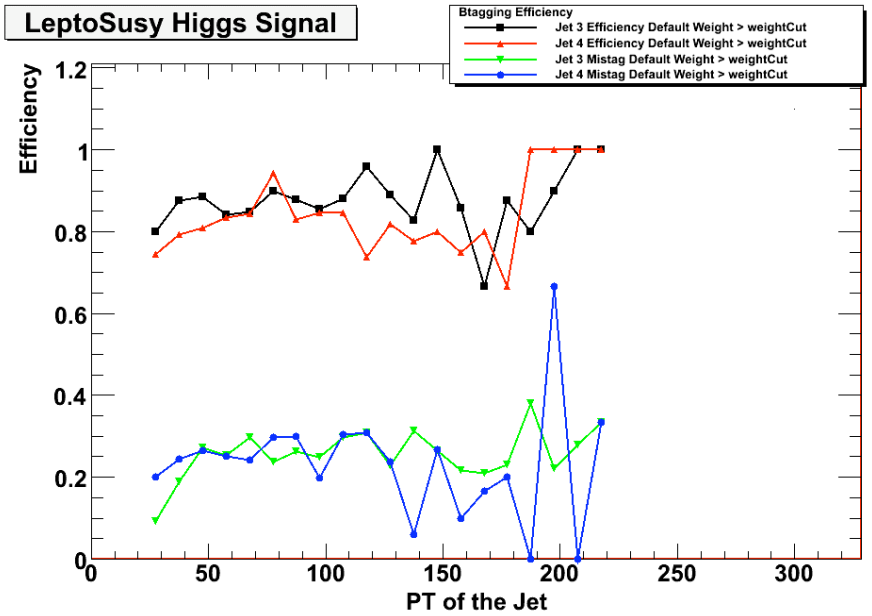
========BTAG Signal : JetProb Cut = 0.1 ========
BTag Efficiency = 0.722222
Light Tag Efficiency (mistag) = 0.0769231
Rejection Factor = 13
========BTAG Background : JetProb Cut = 0.1 ====
BTag Efficiency = 0.923077
Light Tag Efficiency (mistag) = 0.0669291
Rejection Factor = 14.9412

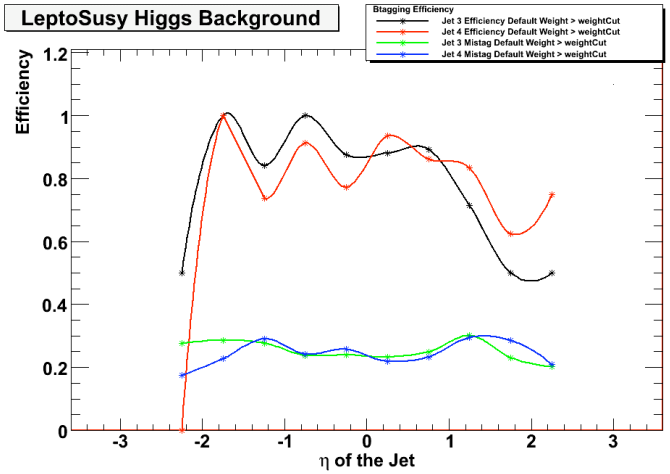


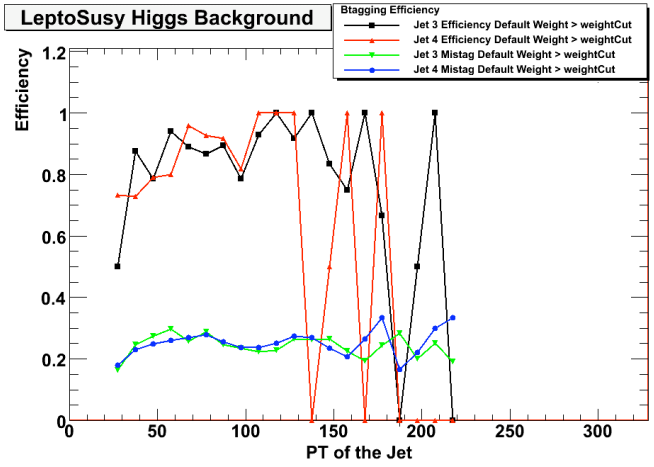


Jet Prob Efficiency

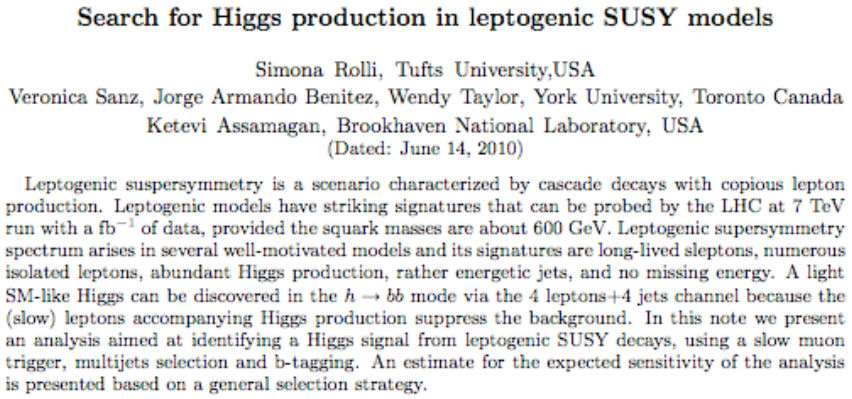








Note



Search for Higgs production in leptogenic SUSY models

Simona Rolli, Tufts University,USA
Veronica Sanz, Jorge Armando Benitez, Wendy Taylor, York University, Toronto Canada
Ketevi Assamagan, Brookhaven National Laboratory, USA
(Dated: June 14, 2010)

Leptogenic suspersymmetry is a scenario characterized by cascade decays with copious lepton production. Leptogenic models have striking signatures that can be probed by the LHC at 7 TeV run with a fb^{-1} of data, provided the squark masses are about 600 GeV. Leptogenic supersymmetry spectrum arises in several well-motivated models and its signatures are long-lived sleptons, numerous isolated leptons, abundant Higgs production, rather energetic jets, and no missing energy. A light SM-like Higgs can be discovered in the $h \to bb$ mode via the 4 leptons+4 jets channel because the (slow) leptons accompanying Higgs production suppress the background. In this note we present an analysis aimed at identifying a Higgs signal from leptogenic SUSY decays, using a slow muon trigger, multijets selection and b-tagging. An estimate for the expected sensitivity of the analysis is presented based on a general selection strategy.

- I started writing a note
  - Introduction
  - LeptoSUSY - Veronica?
  - Data Sample and data selection - Simona
  - Trigger - Jorge Armando
  - B-tagging performance - Simona
  - Slepton reconstruction - Veronica?
  - Plans for real data - Simona, Jorge?
  - Conclusions

Conference sometime in (late) Summer?

To Do: from last time…

- Btagging efficiency as function of PT and eta √
  - Investigate other taggers: JPB √
  - Lepton multiplicities
  - Cleanup of electrons and muons
- Trigger Efficiency: JA √
  - Number of events passing slow muon trigger / number of events with offline slow muon
    - Need to add trigger branch to ntuple (for now only l2pass_mu20Slow)
- InvMass searches code (Argonne)
  - Need to implement the slow muon recognition
  - Possible base for a signature based analysis?
- Taus…
- Start writing a draft note √
- AOB….

L2_mu20_slow

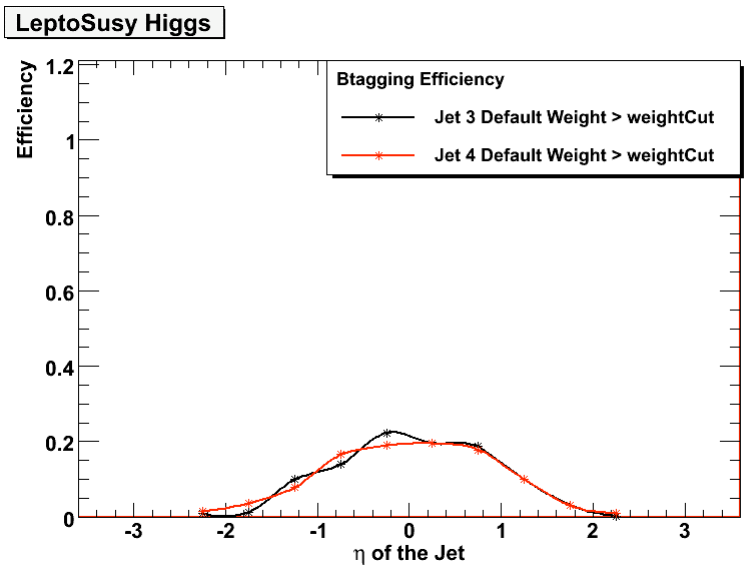
S. Bressler, S. Tarem, S. Vallecorsa

SUSY Trigger meeting - 22/03/2010

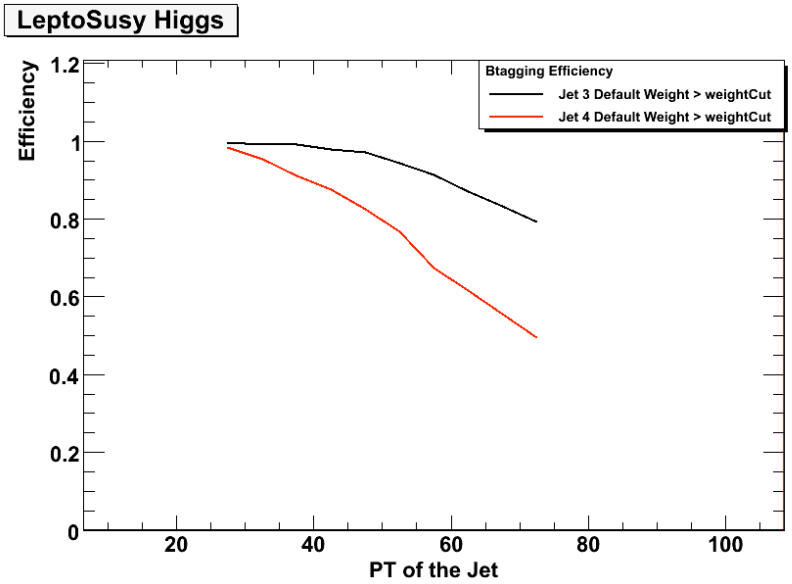
- mu20_slow is part of the physics menu
- It has been specifically designed to trigger on heavy long lived charged particles
- It modifies standard muon triggers to measure β
  - Recover the cases in which no inner detector track is associated to muon spectrometer hits
    - low β candidates or charge flipping R-Hadrons
  - Improve efficiency for low β in EF

- It has very low bkgd rates at 10^{31} and 10^{34}
- It can be activated as soon as RPC and MDT timing are well calibrated

Efficiency vs Eta and PT



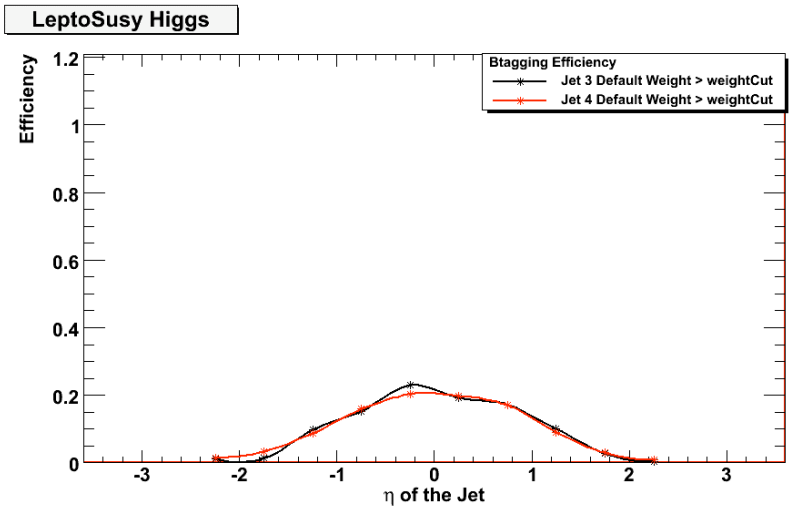
Weight > -1



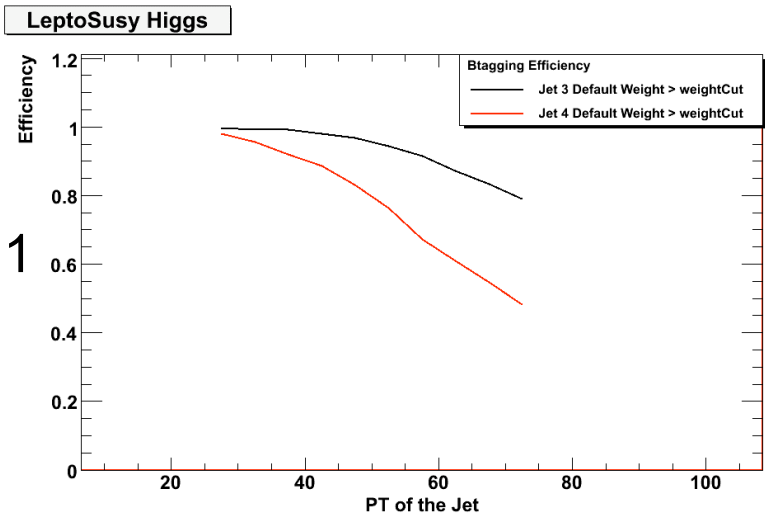
The plots are normalized to jet with Weight Cut, eta/PT cut and flavor == 5
Nothing changes much…

```
if (jetWeight[2] >weightCut   && fabs(jetEta[2]) < 2.5 ) {
 for (int f = 0 ; f < 10 ; f++) {
   if (fabs(jetFlavor[2]) == 5) {
       bTagEffPTDenominator[f]++;
           if ( jetET[2] > 25+5*f    ) bTagEffPTNumerator[f]++; // cumulative!
    } // for (int f = 0 ; f < 10 ; f++)
  } //  if (fabs(jetFlavor[2]) == 5)
 } // if (jetWeight[2] >weightCut  && jetWeight[3] > weightCut && fabs(jetEta[2]) < 2.5 && fabs(jetEta[3]) < 2.5)
```

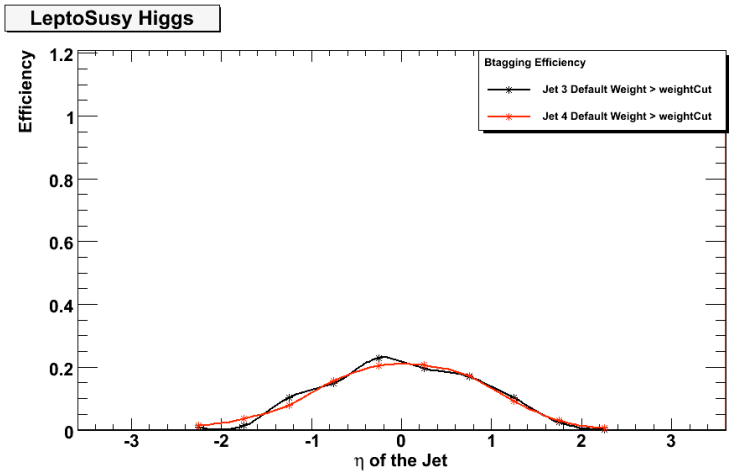
Efficiency vs Eta and Pt



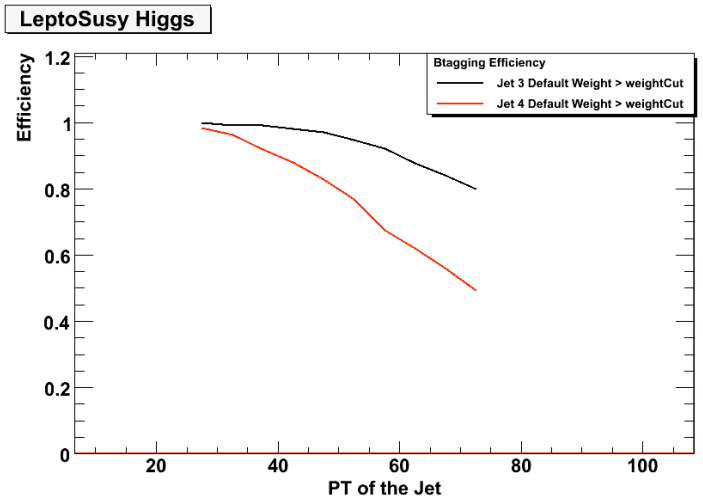
Weight > - 1



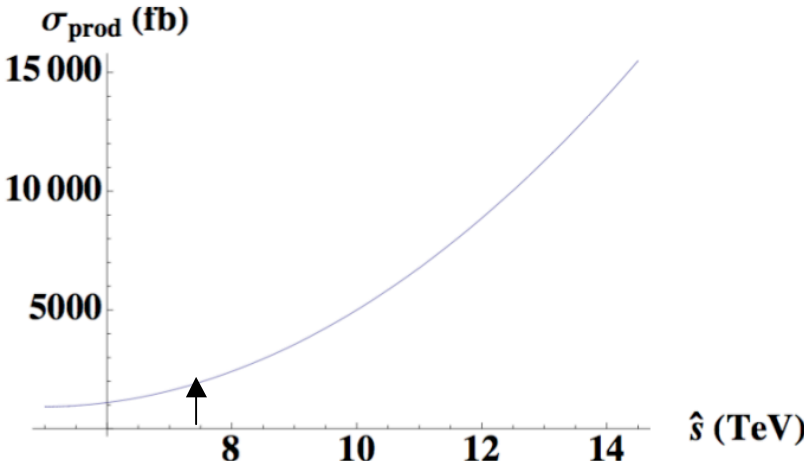
These plots are normalized to jet with weight cut and PT/eta, but not flavor!

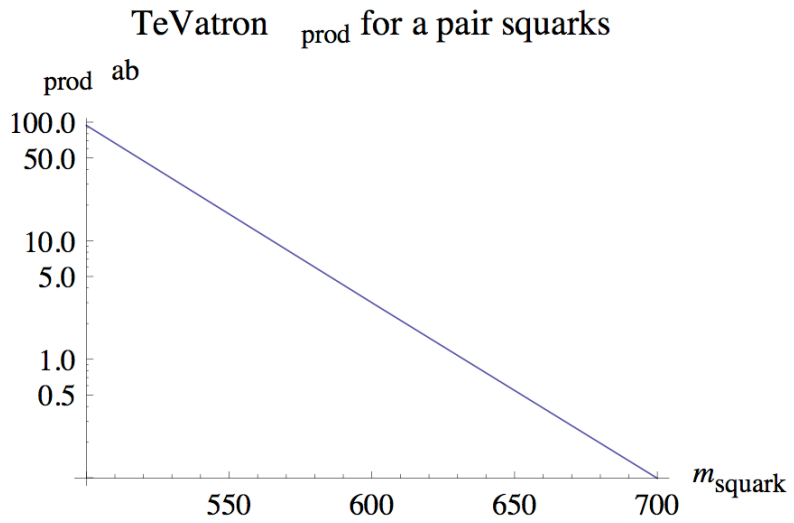


Weight > 0



Cross Section:LHC vs Tevatron





- 1) 7 TeV pp
  - Production cross section: 1.45 pb (240fb for Higgs).
    - q-q initial state is 70%, q-antiq is 20% and g-g is 10%.
- 2) 2 TeV ppbar
  - Production cross section is 159.8 ab (attobarns)
    - q-anti q is 159.5 ab (99%).